Plans for Arecibo Radar Investigation of Mathilde

S. J. Ostro, D. K. Yeomans, D. J. Scheeres, K. D. Rosema (JPL), R. S. Hudson (Washington State U.), D. B. Campbell (Cornell), J. K. Harmon (NAIC)

The Near-Earth Asteroid Rendezvous (NEAR) flyby of 253 Mathilde on June 27, 1997, should produce a mass estimate accurate to about **670.** However, a volume determination from flyby imaging may have uncertainties > 75%; anticipated lightcurve data might reduce the volume uncertainty to between 30% and 50%. Arecibo radar reconnaissance of Mathilde can improve upon these volume determinations in a significant way and can contribute additional, rather valuable constraints on the asteroid's physical properties. Mathilde has a 418-hour rotation period (Mottola et al. 1995, Planet. Space Sci. 43, 1609-161 3) that leads one to expect the echo's signal-to-noise ratio (SNR) to rise from roughly 30/date in mid August to roughly 100/date around Nov. 1 and then fall back to roughly 30/date in early January. SNR is a first approximation to the number of delay/Doppler resolution cells with useful dynamic range that a dataset can place on a target. The long period reported for Mathilde's lightcurve suggests that perhaps this object is a non-principal-axis (NPA) rotator like Toutatis (Hudson and Ostro 1995, Science 270, 84-86). If so, then as with Toutatis, it may prove impossible for lightcurves to disentangle shape and spin-state parameters (Spencer et al., 1995, Icarus 117, 71-89). On the other hand, radar reconnaissance could provide strong constraints on the shape and the eight parameters needed to specify the NPA spin state (two ratios of the principal moments of inertia, Euler angles that orient the principal axes at a specified epoch, and the instantaneous spin vector at that epoch), and hence on the internal density distribution. Thirty daily tracks centered on Nov. 1 could produce a data set with a total SNR of order 500. Additional observations during Aug-Oct and Nov-Jan would improve orientational coverage and could raise the dataset SNR to about 700. Given adequate coverage, it might be feasible to estimate the volume to better than about 15%. There is also an opportunity for Arecibo observations of Mathilde in mid 2001, with SNRS more than twice those available in 1997. Mathilde is in different parts of the sky during the 1997 and 2001 apparitions, which therefore may offer complementary geometric leverage on the asteroid's physical properties.

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The Near-Earth Asteroid Rendezvous (NEAR) flyby of 2.53 Mathilde on June 27, 1997, should produce a mass estimate accurate to about 67o. However, a volume determination from flyby imaging may have uncertainties >75%; anticipated lightcurve data might reduce the volume uncertainty to between 30% and 50%. Arecibo radar reconnaissance of Mathilde can improve upon these volume determinations in a significant way and can contribute additional, rather valuable constraints on the asteroid's physical properties. Mathilde has a 41 8-hour rotation period (Mottola et al. 1995, Planet. Space Sci. 43, 1609-161 3) that leads one to expect the echo's signal-to-noise ratio (SNR) to rise from roughly 30/date in mid August to roughly 100/date around Nov. 1 and then fall back to roughly 30/date in early January. SNR is a first approximation to the number of delay/Doppler resolution cells with useful dynamic range that a dataset can place on a target. The long period reported for Mathilde's lightcurve suggests that perhaps this object is a non-principal-axis (NPA) rotator like Toutatis (Hudson and Ostro 1995, Science 270, 84-86). If so, then as with Toutatis, it may prove impossible for lightcurves to disentangle shape and spin-state parameters (Spencer et al., 1995, Icarus 117, 71-89). On the other hand, radar reconnaissance could provide strong constraints on the shape and the eight parameters needed to specify the NPA spin state (two ratios of the principal moments of inertia, Euler angles that orient the principal axes at a specified epoch, and the instantaneous spin vector at that epoch), and hence on the internal density distribution. Thirty daily tracks centered on Nov. 1 could produce a data set with a total SNR of order 500. Additional observations during Aug-Oct and Nov-Jan would improve orientational coverage and could raise the dataset SNR to about 700. Given adequate coverage, it might be feasible to estimate the volume to better than about 15%. There is also an opportunity for Arecibo observations of Mathilde in mid 2001, with SNRS more than twice those available in 1997. Mathilde is in different parts of the sky during the 1997 and 2001 apparitions, which therefore may offer complementary geometric leverage on the asteroid's physical properties.